Journal of Business and Economics, ISSN 2155-7950, USA
August 2014, Volume 5, No. 8, pp. 1236-1249
DOI: 10.15341/jbe(2155-7950)/08.05.2014/005
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Banks' Capital: The Relevance of Market Signals

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Abstract: The financial turmoil has put into question the effectiveness of the existing regulatory framework for banks. Regulators reacted to the crisis by imposing new capital requirements to achieve both higher and better quality capital, but the theoretical/conceptual framework behind banks' regulation has remained unchanged. Risk Weighted Assets (RWAs) to total assets ratio is the key prudential indicator used to detect/forecast banks' risk. In this paper we use a multi-country panel of European banks to assess the predicting power of RWAs in terms of both banks' risk and unexpected losses. We show that during the crisis market prices (notably price-to-book ratios) were more effective in predicting banks' future distress/losses. Therefore we argue that market-based measures of risk should play a significant role in banks' regulation and supervision.

Key words: Modigliani-Miller; cost of equity; capital regulation

JEL codes: G13, G21, G28

1. Introduction

In a perfect/frictionless world of rational behaviour/expectations and perfect information both the Modigliani-Miller (M-M) propositions (Modigliani & Miller, 1958; 1963) and the Efficient Market Hypothesis (Fama, 1970) hold and are applicable to banking firms. In this framework book values and market values are aligned and have, therefore, the same signaling content, notably in case of impending stress for a bank. The Basel Capital Accords, and notably Basel III, put capital adequacy as the centre piece for banking regulation. Capital is fundamentally defined as an accounting concept (the difference between the book value of a bank's asset and liability positions); assets are risk-weighted to measure minimum required capital ratios. In the Basel framework, accounting/regulatory capital[1] is a cushion against unexpected losses of the bank, measured through Value at Risk (VaR) calculations. Under certain simplifying assumptions, required equity is proportional, given a capital coefficient coherent with the Basel Accords, to volatility in the short run. If we abandon the rarefied M-M assumptions the issue of which measure of capital is more relevant from a supervisory, prompt corrective action (PCA), perspective arises. During the financial crisis, large differences have indeed arisen between market and book values of banks as their market values have sharply eroded on the expectation of major write downs and

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Opinions and ideas expressed in this paper are those of the authors and do not engage in any way their respective Institutions.

[1]For prudential requirements capital is defined (Basel III) more narrowly than in the common accounting framework. Regulatory capital must at all times be freely available to absorb losses. Additional conservatism relates to deducting some assets with uncertain values under stress (such as goodwill) and not recognizing gains not yet realized.

losses on their assets. Banks seem to have used accounting discretion to understate the impairment of their assets in an effort to preserve book capital. In this paper we try to make a contribution to understanding the effectiveness of Risk Weighted Assets (RWAs) as a measure of banks' risks by comparing their predicting power of future losses with the forecasts implicit in market-based indicators (notably price to book ratios). We find support for the thesis that Basel risk-weighted capital ratios had a poor signalling content of a bank's impending crisis, while bank's price to book ratio of equity proved to be an effective early warning of future risks/losses. We are not arguing that market prices always reflect fundamentals and therefore the fair value of a given asset. There is ample evidence that during periods of financial distress excess volatility of asset prices cannot be justified by movements in fundamentals (see Section 2.5). Our thesis is that the signals of the market should be carefully analyzed if the market prices continue to report for a long period of time latent losses on banks' balance sheets, beyond what may be considered as the physiological short-term volatility.

This paper builds upon several strands of literature on banking and capital regulation. Previous empirical work has mainly focused on whether the amount of capital that the banks hold is in line with bank risk (Shrieves & Dahl, 1992; Jacques & Nigro, 1997; Calem & Rob, 1999; Peura & Keppo, 2006; Flannery & Rangan, 2008). Demirguc-Kunt et al. (2011) and Haldane (2011) have emphasized the limits of RWAs as a measure of the effective risks faced by banks. The accounting discretion of banks during a financial crisis was emphasized by Huizinga et al. (2009). They demonstrated that banks with large exposures to Mortgage Backed Securities (MBS) systematically use their accounting discretion so as to inflate asset values and book capital. Specifically, banks with large exposure to MBS were found to report relatively low loan loss provisioning rates and loan charge-off rates, and at the same time they tended to classify a relatively large share of their MBS as held-to-maturity, to be able to carry these assets at amortized costs. There is also research which offers evidence that regulatory capital ratios perform poorly in predicting bankruptcy and distress more generally in the banking industry (e.g., Estrella, Park, & Peristiani, 2000; IMF, 2009). The possible manipulation of Basel risk weights is analyzed by Mariathasan and Merrouche (2013). Our paper is closely related to a recent study of Vallascas and Hagendorff (2013) which analyses how risk sensitive the Basel capital requirements for banks really are. They examine the risk sensitivity of capital requirements for an international sample of large banks between 2000 and 2010 and they demonstrate that capital requirements are only loosely related to a market measure of the portfolio risk of banks.

2. Accounting vs. Financial Valuation: Some Basic Concepts

2.1 Book Value

Book value is the value at which an asset is carried on the balance sheet. In terms of accounting values the balance sheet identity may be written as:

$$A = K + D \tag{1}$$

Where A is the book value of a bank's assets (i.e., the invested/employed capital, according to financial jargon), K is the accounting value of equity, while D is the book value of liabilities (i.e., deposits and debt securities). Currently, bank's accounting values are neither fully based on historical costs nor on market prices: a hybrid approach prevails. In fact, a large part of a bank's assets (i.e., loans and other banking book assets, including government bonds in Held to Maturity, HTM, portfolios) is valued at amortized cost. Market-based prices are used primarily for trading book portfolios. Accounting values' reliability is important for every kind of firm, for banking firms this is even more so. All banks' capital requirements are anchored to book values and "capital" is

the residual accounting item, amounting to some 3-4% of total assets for many large banks.

2.2 Financial Value

In a financial framework the focus is forward looking and is based on present values of expected cash flows (intrinsic value). Account is taken of risk and discount takes place at the appropriate rate of return required by the investor. In this framework the initial assumption is that markets are efficient and prices are related to news on fundamental variables. All relevant information is integrated in current prices. It is only new information which modifies the value of a security (asset). It is assumed that prices and values are constantly and rapidly brought into line.

In the financial value context Equation (1) is replaced by:

$$V = E + B \tag{2}$$

Where V is the financial value of a bank's assets (i.e., the enterprise value of the bank), E is the financial value of equity while B is the financial value of liabilities (i.e., deposits and debt securities).

2.3 Price to Book (Tobin) Ratios

Price to Book/Tobin Ratios (PBRs) are often used by market participants and researchers/analysts to assess banks' incentives to issue new capital and as an indicator of expected returns on bank's equity. PBR of a bank's equity is defined as:

$$PBR_E = \frac{E}{K} \tag{3}$$

A PBR_E higher than 1 indicates that the market is pricing the bank's equity more than what is reported in the balance sheet: there are no signals of potential hidden losses in accounting values. On the other hand, a PBR_E lower than 1 signal that there can be hidden losses priced by the market, but not fully discounted in the balance sheet. This is particularly harmful for a bank, because it suggests that prudential capital ratios, which, as indicated, are defined in terms of accounting values, may overestimate the true capital cushion of the bank. Next, we define the price to book value of a bank's assets as:

$$PBR_V = \frac{V}{A} \tag{4}$$

The same argument adopted for the equity value can be used for the whole value of the bank. A PBR_V value higher (lower) than 1 indicates that the market is pricing the whole bank (its assets) more (less) than what it is expressed in accounting values. It is important to note that there is not a proportional relation between the two indicators. In fact, when the value of the bank expressed by the market is higher compared to what reported in accounting values, all the benefits are enjoyed by equity holders (debt-holders have no up-side potential). On the other hand, when the bank is in trouble, the price to book of the equity holders is lower than the whole price to book of the bank. In fact, equity holders are junior claimants compared to debt holders and therefore the value of their claims on bank's assets discounts higher losses compared to debt holders. This is especially so if debt enjoys, de facto, bail out government guarantees.

2.4 Leverage Ratio: Market vs. Accounting Values

The leverage ratio is a measure of the level of risk taken by a bank as a result of its capital structure. Accounting-based leverage is generally defined as the ratio between the book value of total assets and the book value of equity[2]. Formally:

[2] A number of alternative ratios may be used to measure bank's leverage. For example, debt ratio (total debt divided by total assets) or debt-to-equity ratio (total debt divided by total equity).

$$levBV = \frac{A}{K} \tag{5}$$

The same indicator may be computed using the financial value of a bank's assets and equity. Formally:

$$levMKT = \frac{V}{E} \tag{6}$$

It is important to note that, when the market value of a bank is higher (lower) than the accounting value, the market-based leverage ratio is lower (higher) than the corresponding accounting leverage ratio. As previously pointed out, the market values of total assets and of equity don't change proportionally. The market value of a bank's equity is a convex function of the market value of bank's assets. The market value of equity is easily available for listed banks, while the market value of banks' assets must be estimated through a valuation model. In many cases an easy approximation of the market-based leverage ratio is represented by the quasi-market-based leverage ratio, defined as:

$$qlevMKT = \frac{A}{E} \tag{7}$$

2.5 Financial (Market) Value and Fair Value

Market prices might not be a true and fair assessment of value, especially during a financial crisis. As pointed out, efficient market prices would be a full and fair reflection of the present value of future cash flows on an asset: this is the key message of the Efficient Markets Hypothesis (EMH). As indicated, if the EMH were to hold strictly, the distinction between financial (fair) value and accounting (book) value would not exist. Marking of assets to market would represent a proper recognition of their economic value. In this idealized framework, the interests of accountants, investors and regulators would be perfectly aligned (Haldane, 2010; 2011). Market prices behavior does not fully support the thesis that EMH is always respected, especially during a financial crisis. During periods of financial distress excess volatility of asset prices cannot be justified by movements in fundamentals. Asset prices' signals might be noisy, but correct on average; however, there is growing evidence of asset prices becoming persistently misaligned from fundamentals during a financial crisis. This is mainly due to the emergence of the so called endogenous risk which accounts for the "unexplained" volatility due to non-fundamental factors such as: perverse incentive structures, serially correlated belief structures and risk control methodologies, trend and herding behavior (Danielsson & Shin, 2003; 2011)[3]. Kurz's theory of rational belief (1997), based on a general equilibrium model of market overshoot, highlights that the distribution of serially-correlated belief systems is the primary driver of market volatility[4].

Existing models used for pricing and risk management purposes might produce inaccurate prices and/or predictions. As indicated, risk cannot be considered as a fixed exogenous process. In times of crisis, endogenous risk becomes of paramount importance if agents become more homogeneous in their strategies, precisely because they use similar models. As the crisis develops, the processes driving the underlying data undergo structural breaks. The assumption of stationary stochastic processes is violated. Additionally, data used to estimate forecasting models

[3] More radical approaches to the reliability of market prices question the validity of rational behaviour/expectations of market participants: for a recent model along these lines see Haldane (2012).

[4] An example of excess volatility and multiple equilibriums has been analyzed by Di Cesare et al. (2012) for the recent behaviour of sovereign interest rates in the Euro area. They show that "for several countries the spread has increased to levels that are well above those that could be justified on the basis of fiscal and macroeconomic fundamentals. Among the possible reasons for this gap, the analysis focuses on the perceived risk of a breakup of the euro area". The issue of multiple equilibria and sovereign default has also been analyzed by Gros (2012).

before the crisis become an unreliable basis to estimate risk[5]. In the endogenous risk framework the mapping breaks down, because of the non-stationary, self-correlated re-pricing of fundamentals. In this framework non-linearities between causes and effects become predominant. Strong interactions and converging behaviors of economic agents change the "fundamental" statistical distributions characterizing market under normal conditions. More specifically, there can be a shift from normal-shaped distributions to truncated power laws (heavy tail distributions/extreme value theory, Helbing, 2010) leading to specific risk conditions. In such stress situations contagion can take place and lead to destabilizing downward spirals of asset prices and quantities (market failures)[6].

3. The Empirical Exercises

3.1 Overview of the Data

In this study, we consider a sample of 22 large European bank holding companies that are stock exchange listed, as reported below in Table 1. We use data for the period 2008Q1 to 2013Q3 (23 quarters).

Table 1 Bank Holding Companies in the Sample

Name	Sample	Source
Aareal Bank AG	2008Q1-2013Q3	SNL financial
Banca Carige SpA	2008Q1-2013Q3	SNL financial
Banca Monte dei Paschi di Siena SpA	2008Q1-2013Q3	SNL financial
Banca popolare dell' Emilia Romagna SC	2008Q1-2013Q3	SNL financial
Banca popolare di Milano Scarl	2008Q1-2013Q3	SNL financial
Banco Bilbao Vizcaya Argentaria, SA	2008Q1-2013Q3	SNL financial
Banco BPI SA	2008Q1-2013Q3	SNL financial
Banco Comercial Portugués SA	2008Q1-2013Q3	SNL financial
Banco de Sabadell, SA	2008Q1-2013Q3	SNL financial
Banco Popolare Societacooperativa	2008Q1-2013Q3	SNL financial
Banco Popular Espanol SA	2008Q1-2013Q3	SNL financial
Banco Santander SA	2008Q1-2013Q3	SNL financial
BNP Paribas SA	2008Q1-2013Q3	SNL financial
Commerzbank AG	2008Q1-2013Q3	SNL financial
CréditAgricole SA	2008Q1-2013Q3	SNL financial
Deutsche Bank AG	2008Q1-2013Q3	SNL financial
Erste Group Bank AG	2008Q1-2013Q3	SNL financial
IntesaSanpaoloSpA	2008Q1-2013Q3	SNL financial
KBC Group NV	2008Q1-2013Q3	SNL financial
Mediobanca-Banca di Credito Finanziario SpA	2008Q1-2013Q3	SNL financial
SociétéGénérale SA	2008Q1-2013Q3	SNL financial
UniCreditSpA	2008Q1-2013Q3	SNL financial

[5] Recent instances where endogenous risk developed into systemic risk can be regarded: the Market Crash of October 1987, the 1998 LTCM bail out and, above all, the 2007-2009 financial crisis.

[6] For a review of these concepts see ECB Financial Stability Review (Dec. 2009). See also Schwaab B., Koopman S. and Lucas A. (2011), "Systemic risk diagnostics: coincident indicators and early warning signals" ECB Working Paper No 1327 (April). In the Appendix 1 to this paper the possibility of a vicious circle in case of "required" deleveraging under stress is explored.

Table 2 summarizes the key descriptive statistics of the sample.

Table 2 Descriptive Statistics of the Sample

Variable	Mean	Median	Minimum	Maximum	Std. Dev	Coeff. of variation	5% perc.	95 perc.%
Total Assets (A)€bn	566.050	213.897	30.3286	2289.32	641.968	1.13412	41.7202	1968.85
Equity at book value (K)€bn	26.3465	15.2942	0.822388	95.4690	25.6778	0.974621	2.04741	80.2137
Net income (NI)€bn	0.239872	0.118391	-10.5600	3.01100	1.11437	4.64570	-0.885000	1.89366
Tier 1 ratio (T1)	0.100077	0.0992500	0.0476000	0.182000	0.0235537	0.235356	0.0669500	0.142825
Risk weighted assets to total assets ratio (RWA_A)	0.505398	0.517836	0.139724	0.898602	0.178819	0.353819	0.176620	0.800465
Quarterly flow of new impaired assets (IMP)€bn	0.772389	0.413954	0.00800000	10.7080	0.967262	1.25230	0.0295875	2.62983
Price to book ratio (E_K)	0.688601	0.665669	0.151420	1.79851	0.303604	0.440899	0.263866	1.24299
Accounting based lev. ratio (levBV)	19.3880	16.1029	8.20311	69.0112	8.93468	0.460834	11.0480	38.0548
Quasi-market based lev. Ratio (qlevMKT)	35.2348	27.5361	7.18211	185.077	25.4139	0.721273	11.4609	83.0784

3.2 A First Look at the Evidence

During the years of the euro zone crisis, the quality of euro zone banks' assets deteriorated significantly. On average for the 22 banks included in our sample the quarterly flow of new impaired assets on equity increased from 1.38% in 2008Q2 to 2.23% in 2013Q3 (Figure 1).

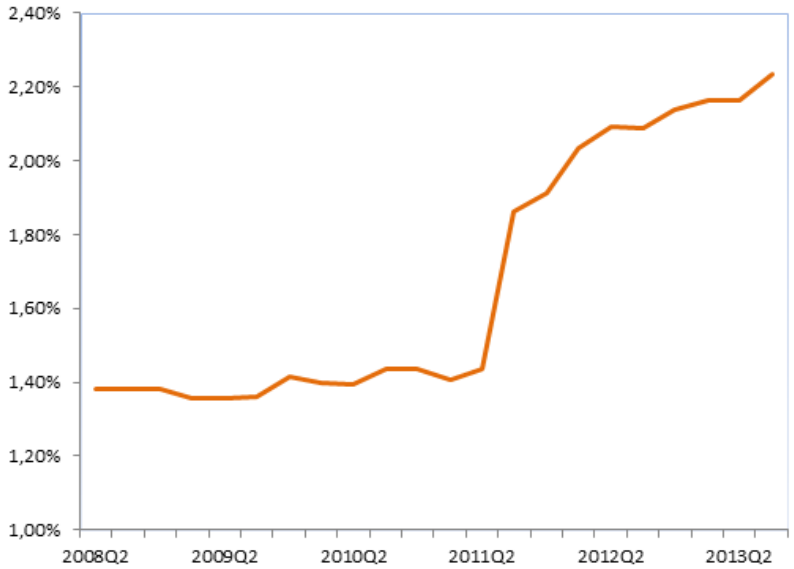

Figure 1 Quarterly Flow on New Impaired Assets on Equity (Average Values Are Asset Weighted, Source: SNL Financial**)**

In the same period regulatory capital held for prudential purposes increased. On average for the 22 banks of our sample the Tier 1 ratio rose from 7.92% in 2008Q2 to 8.18% in 2013Q3 (Figure 2).

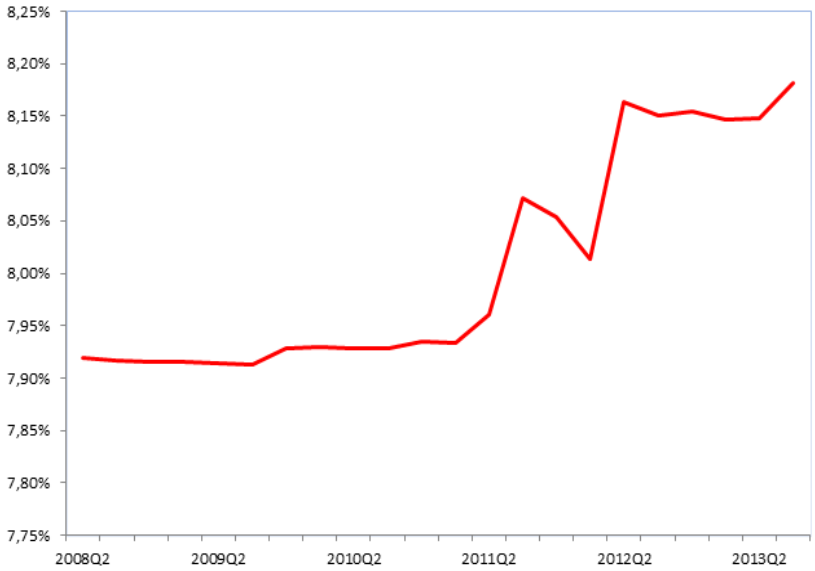

Figure 2 Tier 1 Ratio (Average Values Are Asset Weighted, Source: SNL Financial**)**

The increase in capital ratios was mainly achieved through capital injections but in part was the result of a decrease of the Risk Weighted Assets (RWAs) to Total Assets ratios. On average for the 22 banks included in our sample the RWAs to Total Assets ratio declined from 37.08% in 2008Q2 to 36.34% in 2013Q3 (Figure 3).

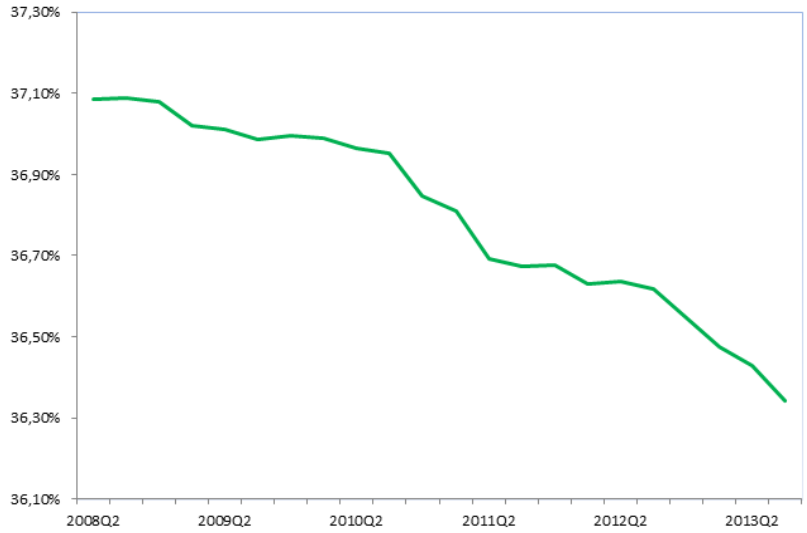

Figure 3 RWAs to Total Assets Ratio (Average Values Are Asset Weighted, Source: SNL Financial**)**

This trend of the RWAs to Total Assets ratio is puzzling given the overall increase of euro zone banks' risks and assets' losses: the evolution of prudential RWAs did not seem to be sensitive/reactive to the effective evolution of banks' risk. The low elasticity of banks' RWAs to the evolution of risk embedded in their assets is confirmed by the scatter plot reported in Figure 4 in which we show the quarterly growth in RWAs to Total Assets ratios and the quarterly growth in assets' new impairments to total assets. The evolution of banks' RWAs did not seem to change in response to the evolution of banks' losses/risks.

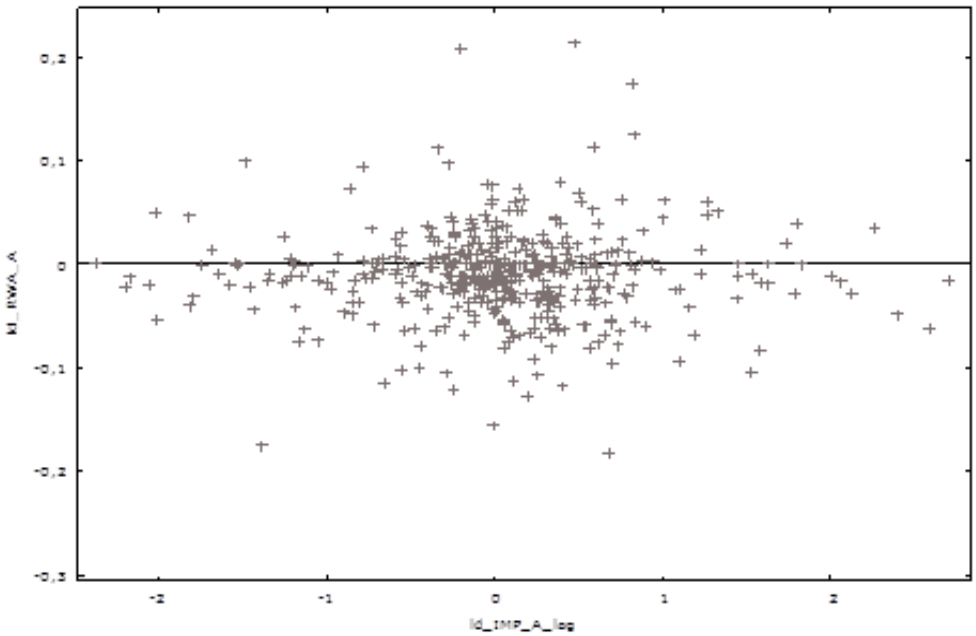

Figure 4 RWAs to Total Assets and New Impairments to Total Assets Quarterly Growth (Source: SNL Financial**)**

On the other hand, market-based measures of risks seemed to signal well in advance the losses/risks faced by the euro zone banks. For our sample the average Price to Book Ratio went from 107.24% in 2008Q2 to 87.74% in 2013Q3 (Figure 5).

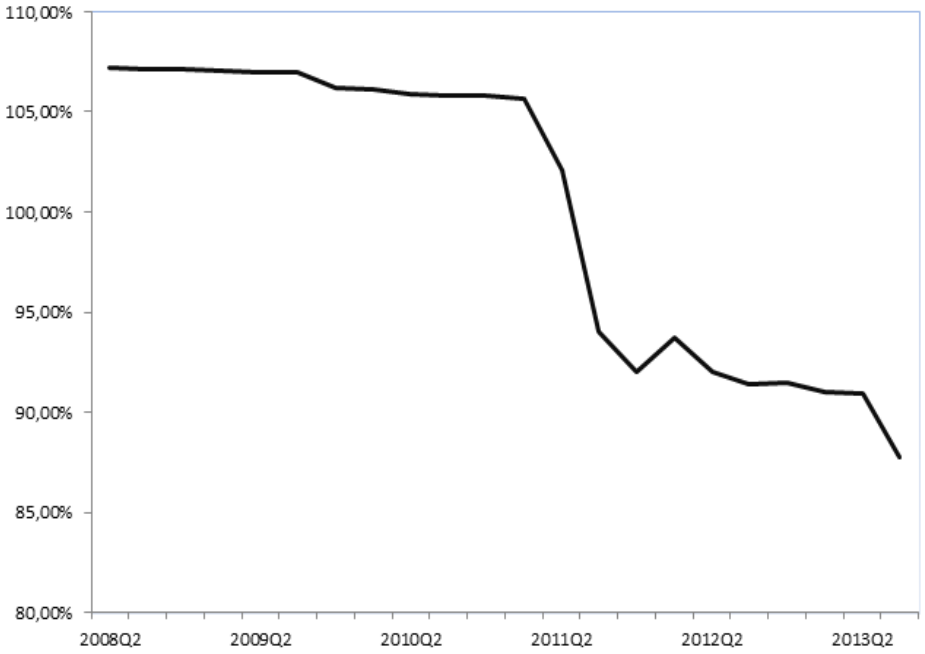

Figure 5 Equity's Price to Book Ratio (Average Values are Asset Weighted, Source: SNL Financial**)**

This evolution indicates that values of assets on banks' balance sheets diverge during stress periods. This may be the result of undershooting of prices, but also of unrecorded book losses. In any case, the relevance and reliability of banks' accounting information is put into question.

3.3 The Empirical Models

In this sub-section we present two empirical models to investigate if market-inferred indicators can be used as early-warning signals: we explore whether market-based capital indicators can single out weak banks on a more reliable and more timely basis, compared to Basel capital measures.

In the first model (Model 1) we estimate the following equation:

$$\begin{aligned} &\Delta IMP_i(t)/A_i(t-1) = \\ &\alpha + \beta\Delta PVEL_i\_E_i(t-1)/A_i(t-1) + \chi\Delta UL_i(t-1)\_RWA_i(t-1) + \\ &+ \gamma_1 d_{2008} + \gamma_2 d_{2009} + \gamma_3 d_{2010} + \gamma_4 d_{2011} + \gamma_5 d_{2012} + \gamma_6 d_{2013} + u_{it} \end{aligned} \quad (8)$$

Where $IMP_i(t)/A_i(t-1)$ is bank i's ratio of the quarterly flow of new impaired asset to previous quarter total assets. $\Delta IMP_i(t)/A_i(t-1)$ is the linear difference of this indicator between the end of quarter t and the end of quarter t-1.

$PVEL_{i\_}E_i\ (t)/A_i(t) = Max[0;K_i(t)-E_i(t)]/A_i(t)$ is the ratio of bank i's potential loss implicit in its equity price to its total assets and $\Delta PVEL_{i\_}E_i\ (t)/A_i(t)$ is the change of this indicator between the end of quarter t and the end of quarter t-1. $UL_i(t)\_RWA_i(t) = 8\%*(RWA_i(t)/A_i(t))$ is bank i's unexpected loss per unit of assets implicit in its RWA. $\Delta UL_i(t)_RWA_i(t)$is the change of this indicator between the end of quarter t and the end of quarter t-1[7]. We introduce also year dummies to control for any possible omitted effect non explicitly specified. We decided to use one quarter lagged values of the explanatory variables to investigate the predicting power of the market-based measures compared to prudential indicators. Results of the regressions both with Random Effect Estimator (REM) and Fixed Effect estimator (FEM)[8] are presented in Table 3.

Table 3 Model 1 Estimation

	REM	FEM
const	-0.0003977	-0.0003987
	(0.0004191)	(0.0004270)
d_PVEL_A_E_K_1	0.05393**	0.05115**
	(0.02353)	(0.02413)
d_UL_A_RWA_1	0.1111	0.1120
	(0.08332)	(0.08666)
DUMMY_2008	0.001627*	0.001636*
	(0.0008411)	(0.0008571)
DUMMY_2009	0.0004017	0.0004040
	(0.0005542)	(0.0005647)
DUMMY_2010	0.0001335	0.0001400
	(0.0005568)	(0.0005674)
DUMMY_2011	0.0007913	0.0008007
	(0.0005595)	(0.0005701)
DUMMY_2012	0.0006937	0.0006970
	(0.0005561)	(0.0005667)
n	440	440
lnL	1881	1883

Note: Standard errors in parentheses; dummy 2013 omitted due to exact collinearity. Period of estimation 2008Q1-2013Q3.
* Indicates significance at the 10 percent, ** Indicates significance at the 5 percent.

[7] There is no evidence of multicollinearity among the two regressors.
[8] The Hausman test suggests that Random Effects Model is the appropriate panel data estimator for this study.

The market based measure (i.e., the losses embedded in equity prices) has a coefficient which is statistically significant with the right sign (positive). This shows that market-based indicators were able to signal in advance the embedded losses recorded in banks' assets only one year later. On the other hand, the unexpected loss implicit in RWA is not statistically significant in predicting the evolution of future banks' losses/profits.

In the second exercise we focus on the market-based measure and we test whether price to book ratios are able to forecast the overall profitability of banks (i.e., their net income). In the second model (Model 2) we estimate the following equation:

$$\begin{aligned} &NI_i(t)/K_i(t-1) = \\ &\alpha + \beta E_i(t-1)/K_i(t-1)_i + \chi levBV_i(t-1) + \\ &+ \gamma_1 d_{2008} + \gamma_2 d_{2009} + \gamma_3 d_{2010} + \gamma_4 d_{2011} + \gamma_5 d_{2012} + \gamma_6 d_{2013} + u_{it} \end{aligned} \tag{9}$$

Where $NI_i(t)/K_i(t\text{-}1)$ is bank i's ratio of net income to previous quarter total equity (at book value, i.e., a proxy of its quarterly ROE). $levBV_i(t\text{-}1)$ is bank i's previous quarter accounting-based leverage ratio and $E_i(t\text{-}1)/K_i(t\text{-}1))$ is bank i's previous quarter equity's price to book ratio[9]. Also in this model we introduce year dummies to control for any possible omitted effect non explicitly specified. Again, we decided to use one quarter lagged values of the explanatory variables to investigate the predicting power of the market-based measures compared to accounting-based indicators. Results of the regressions both with Random Effect Estimator (REM) and Fixed Effect estimator (FEM)[10] are presented in Table 4[11].

Table 4 Model 2 Estimation

	REM	FEM
const	-0.02093**	-0.001918
	(0.008669)	(0.01263)
E_K_1	0.04899**	0.04085**
	(0.008418)	(0.01148)
LEVBV_1	6.386e-05	-0.0007008
	(0.0002596)	(0.0004700)
DUMMY_2008	-0.03100**	-0.02537**
	(0.008575)	(0.009551)
DUMMY_2009	-0.006591	-0.003562
	(0.006523)	(0.006846)
DUMMY_2010	-0.001476	0.0001905
	(0.006552)	(0.006856)
DUMMY_2011	-0.01673**	-0.01658**
	(0.006254)	(0.006326)
DUMMY_2012	-0.008872	-0.008911
	(0.006169)	(0.006168)
n	462	462
lnL	851.5	874

Note: Standard errors in parentheses; dummy 2013 omitted due to exact collinearity. Period of estimation 2008Q1-2013Q3.
* Indicates significance at the 10 percent, ** Indicates significance at the 5 percent.

[9] There is no evidence of multicollinearity among the two regressors.
[10] The Hausman test suggests that Random Effects Model is the appropriate panel data estimator for this study.
[11] In Appendix 2 we present the estimation of Model 2 with Random Effect Estimator (REM) and Fixed Effect estimator (FEM) by considering different forecasting periods (from 1-quarter lag to 4-quarter lag).

Price to book ratio is statistically significant with the right sign (positive) while accounting-based leverage does not seem to explain future banks' profitability. Results reported in Table 4 reinforce the thesis that price to book ratios were able to signal in advance the future evolution of banks' income (and consequently their assets' quality).

4. Conclusions

In this paper we argue that, alongside Basel capital standards, also banks' equity prices, notably price-to-book ratios, should play a significant role in bank supervision, in particular in the framework of Prompt Corrective Action. When the price-to-book goes and stays below unity, value is destroyed (Miller, 1995). Barring distortionary government interventions, equity values consistently below book value indicate that consolidation and restructuring are required, possibly through defaults. More generally, "Simple market based measures of banks equity dominate accounting measures in their crisis predictive performance (Haldane & Madouros, 2012)". The empirical analysis presented is consistent with this thesis. Market-based indicators, such as the price to book ratio, are statistically significant as early indicators of future impaired assets. These results are consistent with the thesis that, during the last crisis, some European banks have exploited their discretion in setting the book value of assets to limit/postpone asset impairment under stress.

Acknowledgement

This note is an update of a working paper titled "Cost of equity, enterprise value and capital regulation of banking firms". The empirical analysis has been enriched with a new dataset and econometric evidence. We would like to thank, without implicating, participants at seminars in Banca d'Italia (February 2013) and Luiss Guido Carli (December 2013), Pietro Alessandrini, Carlo Andrea Bollino, Angela Gallo, Alexander Karmann and Gianfranco Vento for very helpful discussion and criticism of the paper.

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Appendix 1 Deleveraging under Stress: Possible Unintended Side Effects[12]

A.1 In order to improve its capital adequacy a bank can issue new equity and/or reduce its assets. Both approaches result in deleveraging: the latter can imply credit tightening with negative impact on non-financial firms and, ultimately, on GDP. If all banks are simultaneously required to strengthen their capital adequacy, but private capital is not responding because of low expected profitability, a vicious circle can be set in motion. The difficulties are exacerbated under stress conditions, when credit and illiquidity risks become intertwined, with endogenous/systemic risk prevailing[13]. More specifically, if banks are forced simultaneously to sell assets prices may become "undervalued": significant losses are recorded and the banks' capital adequacy can be impaired, instead of improving. These scenarios are explored in this appendix. It should be underlined that, if $PBR_E < 1$, then also $PBR_V < 1$ and, given the convexity of E (since equity holders are junior claimants), $PBR_V > PBR_E < 1$. These relationships hold in reverse if PBR_V and PBR_E are greater than 1.

A.2 If we assume that PBR_V and PBR_E are both equal to 1 (there is no difference between accounting and market values, as is the case in the perfect/frictionless world described in the introduction of this paper), we have:

$$\frac{\partial K}{\partial A} = 0.$$

More specifically, asset sales do not require any value adjustment/loss registration. In this case we record the anticipated effect on the book leverage ratio (and the market leverage ratio which coincide) of an asset sale: leverage is reduced. Formally:

$$dlevBV = dlevMKT = \frac{\partial levBV}{\partial A} dA = \frac{\partial levMKT}{\partial V} dV = \frac{1}{K} dA = \frac{1}{E} dV \cdot$$

Since $dA = dV < 0$ then $dlevBV = dlevMKT < 0$.

A.3 On the other hand, if both PBR_V and PBR_E are less than 1, the book leverage ratio and the market leverage do not coincide. In this case if we sell assets generating a loss not yet recorded in the accounting values we will have to mark-to-market our balance

[12] See also Cour-Thimann and Bernhard Winkler (2013) on the "paradox of deleveraging".
[13] In these conditions securities markets can be characterized by market failures (on this issue see for example Di Cesare et al., 2012).

sheet, by determining a reduction the accounting equity value. Formally:

$$\frac{\partial K}{\partial A} > 0.$$

Therefore:

$$\frac{\partial levBV}{\partial A} = \frac{K - A \times \partial K / \partial A}{K^2}.$$

It is important to point out that:

$$\frac{\partial K}{\partial A} > \frac{K}{A} = \frac{1}{levBV}, \quad \frac{\partial levBV}{\partial A} < 0;$$

and consequently:

$$dlevBV = \frac{\partial levBV}{\partial A} dA > 0$$

since dA = dV< 0. The leverage therefore increases instead of decreasing when we sell assets. More specifically, if endogenous/systemic risk prevails, and equity raising proves very costly in the market, banks may attempt to satisfy capital requirements through deleveraging, but this can backfire. It is important to point out that this is not an extreme situation. For example a bank with a leverage of 30 can record an unintended increase of its leverage if it sells assets by recording a loss of 3.33%.

Appendix 2 Model 2 Estimation with Different Forecasting Periods

Random Effects Model

	(1)	2)	(3)	(4)
const	-0.02093**	-0.01743**	-0.02094**	-0.02671**
	(0.008669)	(0.008707)	(0.008354)	(0.008174)
E_K_1	0.04899**			
	(0.008418)			
LEVBV_1	6.386e-05			
	(0.0002596)			
DUMMY_2008	-0.03100**	-0.05164**		
	(0.008575)	(0.01080)		
DUMMY_2009	-0.006591	-0.005542	-0.009738	-0.01662**
	(0.006523)	(0.006647)	(0.006883)	(0.007277)
DUMMY_2010	-0.001476	-0.002606	-0.002110	-0.005234
	(0.006552)	(0.006851)	(0.006797)	(0.006388)
DUMMY_2011	-0.01673**	-0.01895**	-0.01890**	-0.02389**
	(0.006254)	(0.006466)	(0.006401)	(0.006193)
DUMMY_2012	-0.008872	-0.01021	-0.01391**	-0.01818**
	(0.006169)	(0.006228)	(0.006134)	(0.005871)
E_K_2		0.04302**		
		(0.008636)		
LEVBV_2		7.104e-05		
		(0.0002635)		
E_K_3			0.03817**	
			(0.008041)	
LEVBV_3			0.0004377*	
			(0.0002595)	
E_K_4				0.04848**
				(0.007950)
LEVBV_4				0.0005328**
				(0.0002606)
n	462	440	418	396
lnL	851.5	806.2	774.1	755.1

Standard errors in parentheses; dummy 2013 omitted due to exact collinearity. Period of estimation 2008Q1-2013Q3.
* Indicates significance at the 10 percent** Indicates significance at the 5 percent

Fixed Effects Model

	(1)	(2)	(3)	(4)
const	-0.001918	0.009953	-0.002705	-0.01372
	(0.01263)	(0.01294)	(0.01304)	(0.01301)
E_K_1	0.04085**			
	(0.01148)			
LEVBV_1	-0.0007008			
	(0.0004700)			
DUMMY_2008	-0.02537**	-0.04154**		
	(0.009551)	(0.01196)		
DUMMY_2009	-0.003562	-6.290e-05	-0.002700	-0.01175
	(0.006846)	(0.007034)	(0.007556)	(0.008236)
DUMMY_2010	0.0001905	0.0009828	0.003158	-0.002277
	(0.006856)	(0.007351)	(0.007301)	(0.006886)
DUMMY_2011	-0.01658**	-0.01762**	-0.01583**	-0.02187**
	(0.006326)	(0.006649)	(0.006614)	(0.006518)
DUMMY_2012	-0.008911	-0.01016	-0.01306**	-0.01730**
	(0.006168)	(0.006193)	(0.006133)	(0.005960)
E_K_2		0.02951**		
		(0.01202)		
LEVBV_2		-0.0009847**		
		(0.0004959)		
E_K_3			0.02257**	
			(0.01096)	
LEVBV_3			-0.0001066	
			(0.0005157)	
E_K_4				0.04013**
				(0.01081)
LEVBV_4				6.416e-05
				(0.0005147)
n	462	440	418	396
lnL	874	830	795.2	776.1

Standard errors in parentheses; dummy 2013 omitted due to exact collinearity. Period of estimation 2008Q1-2013Q3.
* Indicates significance at the 10 percent** Indicates significance at the 5 percent